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## DESCRIPTION

SYSTEM FOR DESIGNING VISUAL INFORMATION ON A MONITOR UNIT  
UTILIZED IN COMBINATION WITH A PROGRAMMABLE LOGIC CONTROLLER

## FIELD OF THE INVENTION

The present invention relates to a system for designing visual information on a monitor unit utilized in combination with a programmable logic controller (PLC).

## BACKGROUND ART

A monitor unit has been utilized in combination with a programmable logic controller (PLC) in order to monitor a task performed by I/O devices connected to and controlled by the PLC. The monitor unit includes a display for displaying visual information prepared for informing the task being performed, a controller section for controlling to display the visual information, and a memory for storing the visual information to be selectively reproduced on the display. In order to design the visual information, an image design tool is provided for creating a source display code of the visual information. After completing the design of the visual information on the tool, the source display code is transferred to the monitor unit where the source display code is translated into a corresponding bitmapped image for reproduction of the visual information on the display. Normally, the visual information created on the tool includes a combination of characters and graphic images. The characters are realized as vector fonts by the image design tool or draw program with the use of a font file provided on a computer running the draw program, while the graphic images are realized in a vector-oriented format defined by the program. Therefore, the monitor unit is

required to have additional character ROM for translating the characters into the corresponding bitmapped image as well as to have a capability of translating the graphic images in the vector-oriented format into the corresponding bitmapped image. The more the intended visual information becomes sophisticated with the inclusion of elaborate graphic images and the characters of different font sizes, the more the monitor unit is required to have the translation capability for rapid reproduction of the visual information on the display. To meet this requirement, the prior monitor unit has to incorporate a high speed CPU and a graphic processor, and therefore is realized at a considerably high cost.

#### DISCLOSURE OF THE INVENTION

In view of the above insufficiency, the present invention has been achieved to provide a system for designing visual information on a monitor unit which enables the use of the monitor unit manufactured at a reduced cost but assures rapid reproduction of the intended visual information. The monitor unit is utilized in combination with a programmable logic controller (PLC) for monitoring a task to be performed by I/O devices managed by the PLC. The PLC executes a program for controlling the I/O device connected to the PLC. The monitor unit includes a display, a controller section, and a memory. The system includes an image design tool operating on a personal computer for creating a source display code of the visual information to be reproduced on the display. The characterizing feature of the present invention resides in that the image design tool has a conversion means which translates the source display code into a corresponding bitmapped image and exports the bitmapped image to the monitor unit for immediate reproduction of the visual information on the display.

Consequently, the monitor unit can be dispensed with a costly component of translating the source image code into the bitmapped image, yet effecting rapid reproduction of the visual information on the display directly from the bitmapped image transferred from the image design tool.

Accordingly, it is a primary object of the present invention to provide a system for designing the visual information to be displayed on the monitor unit which allows the use of the less costly monitor unit but assures high speed reproduction of the visual information on the display.

In a preferred embodiment, the monitor unit is defined by a touch screen unit having a touch screen switch which generates a switch output to the PLC in response to a user's action of touching a particular area on the display. That is, the monitor unit, i.e., the touch screen unit is utilized in combination with the PLC also as an input terminal for entry of a specific instruction to be carried out by the PLC for control of the device managed by the PLC. In this connection, the image design tool includes a function of creating a switch control code for defining the switch output, and a transfer function of transferring the switch control code to the memory of the touch screen unit. The switch control code is processed by the controller section of the touch screen unit to associate the switch output to a particular function of the PLC for control of the devices connected to the PLC.

Preferably, the image design tool is programmed to transfer the source display code together with the bitmapped image thereof to the memory of the monitor unit. The image design tool is also programmed to have a retrieve function of retrieving the source display code as well as the switch control code back from the memory of the monitor unit for modification of the visual

information and the switch control code at the image design tool. That is, all the information or data displayed or processed by the monitor unit can be backed-up within the monitor unit to be accessible by the image design tool. Therefore, the modification of the visual information as well as the switch control code can be made without having to back up the data in another system, which is another object of the present invention.

Further, the present invention provides a scheme of rapid reproduction of a graphic image defined by a rectangular frame on the display. The rectangular frame is frequently utilized to be included in the visual information for highlighting a particular message written in the visual information. The image design tool gives a screen area for drawing the visual information therein. The screen area is divided into a plurality of unit zones extending in parallel with each other with each unit zone and having a length and a unit width defined by a fixed number of dots. The image design tool includes a means of drawing the rectangular frame which is written in the source display code and is translated into a corresponding bitmapped image for reproduction on the display. The image design tool is also equipped with a reshaping means of resizing the bitmapped image of the rectangular frame into a modified rectangular frame having a width equal to an integer multiple of the unit width, dividing the modified rectangular frame into one or more segments having the unit width, and transferring the one or more segments to the memory of the monitor unit or touch screen unit so as to be recombined on the display for reproduction of the bitmapped image of the modified bitmapped rectangular frame. Thus, the controller section of the monitor unit can be easy to perform a rapid reproduction of the modified rectangular frame on the display, which is a further object of the present

invention.

Preferably, the rectangular frame is defined as corresponding to a touch sensitive part of the touch screen switch for facilitating to prompt the entry of the instruction.

In a preferred embodiment, the image design tool has a capability of selecting a particular linguistic code from a set of different linguistic codes so as to create the visual information by using a string of characters according to the selected linguistic code. The tool also has a capability of including an identifier of identifying the selected linguistic code into the source display code such that, when the source display code is retrieved from the memory of the monitor unit into the image design tool, the string of the characters of the selected linguistic code is reproduced on the image design tool. Thus, the characters of any linguistic codes employed for the visual information can be successfully replicated at the image design tool without causing character garbling.

The memory of the monitor unit may be configured to include a virtual image area and an actual image area. The virtual image area has a size greater than a screen size given to the display and is provided for loading the bitmapped image to give a virtual image of the bitmapped image therein. The actual image area has a size equal to the screen size of the display and is provided for trimming the virtual image from the virtual image area into an actual image fitted in the screen size and stores the actual image. The actual image is then transferred by the CPU of the monitor unit to the display for reproduction of the visual information on the display. Thus, only the image within the screen size can be simply transferred from the memory without resorting to laborious procedure of checking over-reached portion of the image and making

proportional resizing of the entire image, thereby enabling immediate reproduction of the visual information on the display.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a diagram showing a system for designing visual information on a monitor unit in accordance with a preferred embodiment of the present invention;

FIGS. 2A to 2E are views showing different pages displayed on the monitor unit realized by a touch screen unit;;

FIG. 3 is a schematic diagram showing a configuration of the touch screen unit;

FIG. 4 is a view explaining the transfer of data between an image design tool and the touch screen unit;

FIG. 5A illustrates one particular page which is designed to be displayed on the touch screen unit;

FIG. 5B is a view showing the content of data transferred from the image design tool to a memory of the touch screen unit;

FIG. 6A is a view showing rectangular switch frames included in an image created at the image design tool; and

FIGS. 6B to 6D show a scheme of resizing the rectangular switch frame in the image for easy handling at the touch screen unit.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Referring now to FIG. 1, there is shown a system for designing visual information on a monitor unit 30 in accordance with the present invention. The monitor unit 30 is realized by a touch screen unit which is utilized in combination

with a programmable logic controller (PLC) **40** as a monitor of displaying information of a task being performed by I/O devices **50** managed by PLC **40** and also as an input terminal for entry of specific instructions to be carried out by PLC **40** for control of I/O devices **50**. PLC **40** executes its own program for control of the I/O devices **50**. For easy understanding of present invention, it is illustrated in the specification and drawings that PLC **40** manages the I/O devices **50** for continuous production of parts as one typical application of PLC **40**. The monitor unit **30** (hereinafter referred to as the touch screen unit) is therefore programmed to provide visual information associated with the production of the parts so that a user is informed of the status of the parts production as well as that the user is guided by the visual information to enter the specific instruction. The touch screen unit **30** includes a touch screen switch **33** (hereinafter referred to simply as touch switch) which provides switch outputs in accordance with the entry of the instructions for carrying out particular functions at PLC **40**.

In order to create the visual information and switch control code which is included in the visual information for allocating the switch outputs to the particular functions at PLC **40**, the system includes an image design tool **20**, i.e., a draw program which runs on a personal computer **10**. As shown in FIGS. 2A to 2D, the visual information to be created at the image design tool are classified into four pages, i.e., a top menu page **60**, a first selected page **61** for entry of intended production numbers of the parts, a second page **62** for entry of actions, and a third page **63** for display status of the operation.

As shown in FIG. 3, the touch screen unit **30** includes a controller section **31** including a CPU, a display **32**, the touch switch **33**, a memory **34**, and an interface **35**. The display **32** is in the form of a liquid crystal display (LCD)

having a screen and including a driver for reproduction of the visual information as bitmapped image on the screen by the controller section 31. The touch switch 33 has an array of touch sensitive transparent areas covering the screen and each providing the switch output in response to being touched by the user. The memory 34 stores the visual information and the switch control code created by the image design tool 20. The interface 35 is provided for transmission of the visual information and the switch control data between the memory 34 and the image design tool 20 and also for transmission of control data between the controller section 31 and PLC 40.

The visual information created at the image design tool 20 is composed of base images **B** and rectangular switch frames **SF** overlayed on the base image. The base image is a background image appearing on each of the pages **60** to **63** and includes a string of characters and a graphic image such as a rectangular and a line. As shown in FIGS. 2A to 2D, the switch frames **SF**, which are provided at the pages **60** to **63** and illustrated with shadow lines, give user interface switches. In addition to drawing the switch frames, the image design tool has a function of determining switch actions of the switch frames. The switch actions includes, for example, switching of the pages on the display and designation the instruction to be transferred to PLC 40 for execution of particular routines of the program. In addition, the image design tool 20 sets an environment data **64** such as a screen size and a backlight screen color of the display 32. As shown in FIG. 4, the visual information (page 0, page 1, page 2, and page 3) including the switch control code for each page as well as the environment data **64** are created at the image design tool 20 for transfer to the memory 34 of the touch sensor unit 30. The visual information is created as a

source display code which is to be translated into a corresponding bitmapped image for reproduction of the visual information on the display **32**. Also, the switch control code is created as a source code which is translated at the controller section **31** into a suitable format to be executed thereat. Thus, each of pages **60** to **62** is defined by a combination of the source display code of the visual information and the source code of the switch control code.

Further, the image design tool **20** is programmed to have a conversion function of translating the source display code into the bitmapped image and exporting the bitmapped image as being attached to the source display code (page 0, page 1, page 2, and page 3) for each page, as shown in FIG. 4. The touch screen unit **30** operates to read the bitmapped image for immediate reproduction on the display **32** and to translate the switch control code for execution of the switch action. Also, the image design tool **20** is programmed to have a retrieve function of retrieving the source display code and the switch control code back from the memory **34** for modification of the visual information and the switch control code at the image design tool **20**.

Now more detailed explanation will be made as to the contents of the visual information with reference to FIGS. 5A and 5B. FIG. 5A shows the visual information of page **62**, while FIG. 5B shows the contents of the visual information of page **62** and the associated switch control code. The page **62** includes the base image with the strings of characters "Please Select" and "page 2" and the graphic line, i.e., the underline below the string "Please Select", and two rectangular switch frames **SF** labeled as "Continuous Operation" and "Stop" and defining the first and second switches, respectively. Each rectangular switch frame **SF** includes a graphic image of rectangular and a string of

characters "Continuous Operation" or "Stop", and has the switch control code embedded behind the rectangular frames. The characters for the base image as well as the switch frames are realized by vector fonts with the use of a font file equipped on the computer running the image design tool, while the graphic images for the base image as well as the switch frames are realized in vector-oriented format of the image design tool. The visual information thus including the characters and the graphic images for page 62 are translated at the image design tool 20 into the corresponding bitmapped image (BMP) which are appended to the source code of the visual information and the switch control code. That is, as shown in FIG. 5B, the data of page 62 is mainly composed of a page tag 71 specifying page 62, bitmapped image (BMP) 72 of the base image, switch display data 81 of the first switch, switch display data 82 of the second switch, character data 73 for the characters of the base image, graphic data 74 for the graphic image of the base image, switch control code 91 of the first switch, and switch control code 92 of the second switch.

Each of the switch display data 81 and 82 includes a switch tag 83 specifying the corresponding switch, size information 84 defining the size of the corresponding switch frame, and bitmapped image (BMP) 85 of the corresponding switch frame. The character data 73 includes a character tag 75 specifying the character information, locating information 76 designating locations of the characters, font information 77 for fonts utilized for the characters, linguistic code information 78 specifying a particular linguistic code or a character set utilized for the characters, and character codes 79 defined by the linguistic code to represent the characters utilized. In this connection, the image design tool 20 has a capability of selecting a particular linguistic code from a set of different

linguistic codes so as to include the string of characters according to the selected linguistic code, and of including the selected linguistic code into the source display code. Whereby, when the source display code is retrieved from the memory 34 of the touch screen unit 30 to the image design tool 20, the string of the characters of the selected linguistic code can be successfully reproduced on the image design tool 20.

Each of the switch control code 91 and 92 includes a switch tag 93 specifying the switch control code, an effective range 94 in the display screen within which the switch is capable of being actuated, an operation mode 95 specifying the function of the switch, and a target designation 96 for specifying a target to be driven by the switch output. The function of the switch specified by the operation mode 95 includes making the switch as a momentarily actuated switch or alternately actuated bistable switch, for example, and also making the switch output as a command for changing the pages on the display 32. When the operation mode 95 is set to make the switch output as the command for changing the pages, the target designation 96 specifies the page of the visual information. Otherwise, the target designation 96 specifies the device 50 to be controlled by PLC 40.

Referring to FIGS. 6A to 6E, the present invention employs a unique scheme of resizing the bitmapped image for the rectangular switch frame into a suitable format and transferring the resized bitmapped image to the memory 34 of the touch screen unit 30 so that the controller section 31 can reproduce the bitmapped image on the display 32 at a high speed. When the visual information includes the rectangular switch frames **SF** as shown in FIG. 6A, the

image design tool **20** analyzes the size of the bitmapped image for the rectangular frame **SF** and resize the switch frame **SF** when transferring the bitmapped image to the touch screen unit **30**. The image design tool **20** provides a screen area **21** for drawing the visual information therein. The screen area **21** is divided into a plurality of elongated unit zones or bands **22** each having a unit width of eight (8) dots, as shown in FIG. 6A. When, for example, the switch frame **SF** labeled "Cancel" is made to have a width not corresponding to an integer multiple of the unit width, i.e., have the upper and lower sides of rectangular switch frame **SF** disposed between the borders of the bands **22**, as shown in FIG. 6B, the image design tool **20** adds extra blank spaces in the rectangular switch frame **SF** to such an extent that the upper and lower sides of the rectangular frame are in registration with the borders of the bands **22**. Thus, the rectangular switch frame **SF** is resized to have a width which is an integer multiple of the unit width, as indicated by the solid lines in FIG. 6C. The resized rectangular switch frame **SF** is divided into segments ①, ②, and ③ each having the unit width, as shown in FIG. 6D. Then, the resized rectangular switch frame **SF** is transferred in the form of the divided segments to the memory **34** of the touch screen unit **30**. In this manner, since the rectangular switch frame is resized so as to be divided into the segments of unit width, the controller section **31** of the touch screen unit **30** is capable of expanding the switch frame from the memory segment by segment and therefore assuring a high speed reproduction of the switch frame on the display **32** of the touch screen unit **30**.

The memory **34** is configured to have a basic memory area storing all the data transmitted from the image design tool **20**, and have additional areas,

namely, the virtual image area and an actual image area. The virtual image area has a size greater than a screen size of the display 32, while the actual image area has a size equal to the screen size of the display 32. In this connection, the screen area available at the image design tool 20 for drawing the visual information is made to have a size slightly greater than the screen size of the display 32 for giving design flexibility. The bitmapped image stored in the basic memory area is loaded to the virtual image area to give a virtual image of the bitmapped image. The virtual image is then loaded into the actual image area where it is trimmed into an actual image fitted in the screen size. Thereafter, the controller section 31 transfers the actual image to the display 32 for reproduction of the actual image thereat. In this manner, only the image within the screen size can be simply transferred from the memory without resorting to laborious procedure of checking over-reached portion of the image and making proportional resizing of the entire image, thereby enabling immediate reproduction of the visual information on the display only at an expense of canceling the over-reached portion around the virtual image.